

Conference Paper

Use of Drill Cuttings for Road Building

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Abstract

The negative impact on the environment from drill cuttings resulting from drilling wells for oil production is assessed in this article. Environmental hazards are contaminants such as petroleum products, drilling fluid reagents, and chemical compounds of heavy metals that make up drill cuttings. To assess the negative impact, the heavy metal content indicators and chemical analysis parameters of drill cuttings were determined. It has been established that there are no excesses in the standards for the content of heavy metals in drill cuttings. The results of chemical analysis showed that there are excesses in values: MPC (Maximum Permissible Concentrations), COD (Chemical Oxygen Demand), oil content, solids, hardness, magnesium and calcium ions, chlorides. Two directions of utilization of drill cuttings were selected: the use of drill cuttings in the construction of the foundation of the road, and obtaining material based on drill cuttings to strengthen slopes. A technoground was obtained in the form of a lumpy material for placement in a barn and further excavation for filling embankments and strengthening soil. In preliminary studies, it was found that the technoground sample with the following component composition has the most stable strength characteristics: cement - 20%; drill cuttings - 80%; liquid glass - 2% over 100% of the mixture.

Keywords: drill cuttings, negative impact, environment, utilization, technoground.

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In Russia, during the development of oil fields, a large number of drilling operations are carried out during which drill cuttings (hereinafter referred to as DC) are formed, which is an aqueous suspension, the solid part of which consists of products from the destruction of rocks of the face and borehole walls, products of abrasion of the drill string and casing, clay minerals (when washing with a clay solution). DC are large-scale waste and a source of significant environmental pollution [1]. About 300 thousand of such waste is formed annually. More than 95 million DC have been accumulated in Russia [2].

Organizations engaged in drilling operations should place the resulting DC in special drilling barns. At the same time, a large number of organizations violate this requirement and place DC on unprepared sites, which forms a negative impact on environmental objects.

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The mineralogical composition of DC depends on the lithological composition of the rocks being drilled and changes as the well deepens and the place of extraction of minerals. The granulometric composition of DC is determined by the type and diameter of the rock cutting tool, the mechanical properties of the rock, and the properties of the flushing fluid. DC according to the classification of the FCCW (Federal Classification Catalog of Wastes) are classified as hazard class IV.

The degree of contamination depends on the type of drilling fluid that is required for drilling. Drilling fluid is a complex multicomponent disperse system of suspension, emulsion and aerated fluids used for flushing wells during drilling. In practice, drilling fluids are used on aqueous (industrial water, salt and hydrogel solutions, polymer, polymer-clay and clay solutions) and hydrocarbon (lime-bitumen, invert emulsion) substrates. Previously, an oil-based solution was used, but due to its high toxicity it was banned in almost all countries [3].

The total composition of DC includes components: water - 25%; cuttings - 60%; chlorides - up to 0.5%; heavy metals - 6%; drilling fluid reagents - 8%; other compounds - 0.5%.

An analysis of the scientific literature showed that the main impact is on the lithosphere due to the inclusion of oil and its fractions, which are considered the main toxic agent, in DC composition. Also dangerous are toxic substances added to the drilling fluid in the form of various chemical reagents: ether-retrievable compounds, cellulose-based polymer, clay powder, KMC-600, xentan gum, lignin and sulfolignin, etc. Reagents are needed to reduce the water loss of the formation, to reduce the viscosity of the solution.

DC are stored in a barn or barn-free method. For their placement, land plots are seized, while the flora and fauna around the storages are destroyed.

In the works of the authors Vasilyev A. and Xu T. it was shown that when the waterproofing of the slurry barn is disturbed, the productivity of the soil cover decreases, and groundwater pollution occurs [4, 5]. The toxins contained in the sludge are washed away into the ground by atmospheric precipitation and, then, are transported into the rivers by groundwater. As a result, inhibition and suppression of organic life, a change in the composition of biocenoses.

In the works of the authors Mostavi E. and Kujawska J. air pollution is shown, which consists in the fact that, under the influence of direct sunlight, intense evaporation of light hydrocarbon fractions occurs [6, 7].

In the works of the authors Junttila J. and Arley S. Rossi data on the effect on soil, flora and fauna, which consists mainly in oil pollution, are given [8, 9]. Violated the air regime and water properties of soils. There is a decrease in the number of

cellulose-degrading microorganisms that assimilate nitrogen compounds. Inhibition of redox enzymatic processes occurs, which reduces soil fertility and biological activity.

Thus, DC have a complex negative impact on humans and natural ecosystems. One of the practical tasks is to minimize the negative impact of DC on the environment.

In this regard, laboratory studies of DC were carried out to determine physical and chemical parameters and the content of heavy metals, and based on the results obtained, possible ways of its use were outlined. DC were sampled at several fields in the Russian Federation (see Table 1): Sample No. 1 - Orenburg Oblast, Sample No. 2 - Tomsk Oblast, Sample No. 3 - Yamal-Nenets Autonomous Okrug. It has been established that there are no excess standards for the content of heavy metals in mobile form.

TABLE 1: The content of heavy metals in DC samples

Name	The content of heavy metals, mg/kg						
	Cadmium	Chrome	Nickel	Cobalt	Plumbum	Cuprum	Manganese
DC sample No. 1	less than 0,2	1,8±0,4	0,60±0,18	less than 4	less than 5	2,0±0,5	23±4
DC sample No. 2	less than 0,2	0,74±0,23	3,0±0,8	1,2±0,4	3,4±0,9	3,3±0,8	51±8
DC sample No. 3	less than 0,2	1,08±0,27	2,3±0,6	0,96±0,29	1,8±0,5	0,62±0,19	112
The value of the permissible value (PND F 16.1: 2.3: 3.50-08)	1,0	6,0	4,0	5,0	6,0	3,0	600,0

Water extracts were also prepared from DC samples dried at 105° C to constant weight to determine chemical parameters. An analysis of the results (see Table 2) of quantitative chemical analysis showed that there are excesses in values: MPC (Maximum Permissible Concentrations of harmful substances in the waters of fishery water bodies), COD (Chemical Oxygen Demand), oil products, solids, hardness, magnesium ions and calcium, chlorides.

In order to reduce the negative impact, it was proposed to use DC resource potential in the construction of roads. Two directions of DC utilization were chosen: the use of DC for the construction of the foundation of the road and the production of material based on DC to strengthen the slopes.

Initial studies on the production of technoground based on DC sample No. 1 were carried out. Used dried at 105° C to constant weight DC. In the first series of the experiment, mixtures with different contents of cement grade PC-400 and water glass

TABLE 2: Quantitative Chemical Analysis Results

Defined characteristics	Units	Analysis results			Limit of permissible concentrations
		DC sample No. 1	DC sample No. 2	DC sample No. 3	
pH	un.pH	6,9 ± 0,05	7,1 ± 0,05	7,8 ± 0,05	6,5-9,0
Chemical Oxygen Demand	mgO ₂ /dm ³	1300 ± 65,0	278 ± 13,9	444 ± 22,2	30
Oil product	mg/dm ³	4,4 ± 0,88	2 ± 0,4	2,70 ± 0,9	0,05
Dry residue	mg/dm ³	1590,0 ± 159,0	1110 ± 111,0	1800 ± 180,0	1000
Rigidity	Mmol-eq/dm ³	60 ± 3,0	3,5 ± 0,18	23 ± 1,15	10,0
Calcium ion	mg/dm ³	800 ± 40,0	46,70 ± 2,4	306 ± 15,3	180,0
Magnesium ion	mg/dm ³	240 ± 12,0	14 ± 0,7	92 ± 4,6	40,0
Chlorides	mg/dm ³	1411,1 ± 70,6	258 ± 12,9	1650 ± 82,5	300

(diluted with water in a ratio of 1:5) and with the addition of a small amount of water (10% of the mixture of cement and sand) were mixed.

After five days with visual inspection, it was found that samples with a cement content of more than 25% and less than 15% were covered with cracks and were very fragile upon tactile contact. After that, the samples were placed in water, and after 5 minutes, the destruction of the samples to a lumpy state began. After keeping the samples in water for a day, lumpy elements of various fractions were obtained: 2–20 mm. (see Figure 1). Based on this, it is proposed to use the resulting lumpy material (technoground) for placement in a barn and further excavation for filling embankments and strengthening soil.

A series of experiments with various compositions was carried out, using wet DC (humidity 60%), water was not added, since the mixture acquired the necessary creamy shape when mixing the components, according to the technological process. Samples were kept for five days. During visual inspection and tactile contact, it was established that the sample with the following component composition has the most stable strength characteristics: cement - 20%, DC - 80%, liquid glass - 2% over 100% of the mixture (see Figure 2).

Based on the preliminary analysis, the necessary proportions of the mixtures were selected, and refinement laboratory studies are currently underway to assess the compliance of the products with regulatory documents. Indicators are determined: compressive strength, elastic modulus, particle size distribution of the mixture, frost resistance, abrasion, etc.

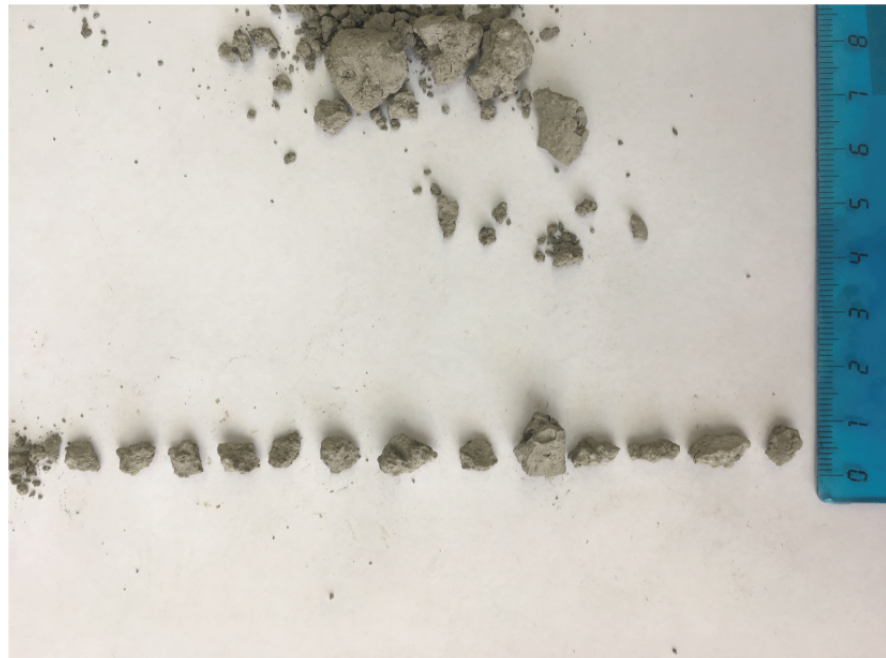


Figure 1: Lumpy material obtained



Figure 2: Appearance of the obtained sample after aging for five days

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